

PERSONAL

P. Read Montague (www.hnl.bcm.edu)

Citizenship: USA

EDUCATION

1983 B.S. Mathematics, Auburn University
1985 Neurobiology Course, MBL, Woods Hole, MA
1988 Ph.D. Biophysics, University of Alabama at Birmingham School of Medicine
1989-91 Institute Fellow in Theoretical Neurobiology, The Neurosciences Institute, Rockefeller University (sponsor: Gerald Edelman, MD PhD)
1991-93 Fellow and Staff Scientist, Computational Neurobiology Lab
The Salk Institute for Biological Studies (sponsor: Terrence Sejnowski, PhD)

ACADEMIC APPOINTMENTS

2006 - present **Honorary Professor**, Gatsby Computational Neuroscience Unit, UCL
2005-2006 **Member**, Institute for Advanced Study (Princeton, NJ)
2003-present **Brown Foundation Professor of Neuroscience**
Baylor College of Medicine
2003-present **Professor**, Menninger Department of Psychiatry and Behavioral Sciences
Baylor College of Medicine
2001-present **Director**, Human Neuroimaging Lab, Baylor College of Medicine
2001-present **Professor**, Department of Neuroscience
Baylor College of Medicine
1998-2001 **Associate Professor**, Division of Neuroscience
Baylor College of Medicine
1993-1998 **Assistant Professor**, Division of Neuroscience
Baylor College of Medicine
1992-93 **Staff scientist**, Computational Neurobiology Lab
The Salk Institute for Biological Studies
Other faculty appointments: **Adjunct Professor**, Department of Computer Science
Rice University, Houston TX

NATIONAL SCIENTIFIC PARTICIPATION

Review panels: **NIMH Cognitive Function Study Section**, 1997, 1998
NASA Neuroscience (ground) panel, 1999
NIH study section IFCN 8:
Integrative Functional Cognitive Neuroscience 8 1998-2002
Ad hoc reviewer - National Science Foundation
The Wellcome Trust
NIH Director's Pioneer Award (NDPA) review panel, 2004
Reviewer for: *Cerebral Cortex, Journal of Neurochemistry, Journal of Neuroscience, Journal of Theoretical Biology, Journal of Computational Neuroscience, Journal of Neurophysiology, Nature, Nature Neuroscience, Neural Computation, Network: Computation in Neural Systems, Psychological Review, Science, The Lancet, Journal of Cognitive Neuroscience, Neuron, NeuroImage*
Organizer for:
2004 Neuroeconomics 2004, Kiawah Island, SC Sept. 16-19
2005 Theoretical Methods in Neuroscience I (<http://www.hnl.bcm.edu/tmn/index.html>)
2006 Theoretical Methods in Neuroscience II (<http://www.hnl.bcm.edu/tmn2/index.html>)

Invited Presentations (last 3 years)

2007 Winter Conference on Brain Research, Snowmass Village, CO, Jan 22-Feb 2
2007 Wellcome Trust, Computational Neuroscience Frontiers Meeting, London, Apr 16-17
2007 University of Alabama Birmingham, Apr 29-May 1
2007 Cognitive Neuroscience Society Annual Meeting, New York, May 5-6
2007 Reciprocity and Influence, AAMC, Washington Marriott, Washington, DC, Jun 12
2007 International Society for New Institutional Economics conference, Reykjavik, Iceland, Jun 21-23
2007 Gordon Research Conference, Salve Regina University, Newport, Rhode Island, Jul 1-6

- 2007 NIDA Science Meeting- Social Neuroscience: Developing More Powerful Behavioral Interventions, Oct 1-2
- 2007 Annual Keck Center Research Conference, Southshore Harbor Conference Center, League City, Oct 11-12
- 2007 Keynote speaker-Computational Cognitive Neuroscience Conference, San Diego CA, Nov 1
- 2007 37th Annual Society for Neuroscience Meeting, San Diego, CA, Nov 3-7
- 2007 Massachusetts Institute of Technology, Cambridge, MA, Nov 30
- 2007 Harvard University, Department of Economics, The Behavior and Experimental Economics Workshop, Dec 11
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- 2006 Berkeley Art Museum, Neuroaesthetics conference, Jan 21-22.
- 2006 Redwood Center for Theoretical Neuroscience (Univ. of California) Berkeley, CA, Jan 23.
- 2006 Brown Symposium @ Southwestern University, Feb 9-10.
- 2006 AAAS Annual Meeting, St. Louis, Feb 16-20.
- 2006 Department of Psychiatry, Massachusetts General Hospital, Mar 2.
- 2006 Vanderbilt University, Nashville, TN, Mar 9.
- 2006 The Mahoney Institute of Neurological Sciences, University of Pennsylvania, Apr 5.
- 2006 Department of Neurobiology Center for Cognitive Neuroscience, Duke University, Apr 7.
- 2006 UCLA Lake Arrowhead Conference Center in San Bernardino, CA, Jun 1-4.
- 2006 Caltech Mini-symposium on Neuroeconomics, Jun 5.
- 2006 Human Brain Mapping Meeting, Florence, Italy, Jun 11-15.
- 2006 American Association for the Advancement of Science, Washington, DC, Jun 28-30.
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- 2005 Mars Nutrition Research Council, Jan 5
- 2005 Texas Academy of Medicine, Engineering, & Science, Jan 7, Dallas TX
- 2005 UAB Department of Neurobiology, Birmingham, AL, April 6.
- 2005 Columbia University School of Business retreat. May 13,14.
- 2005 Decision-making workshop, Banbury Center, Cold Spring Harbor Lab, NY, May 22-25.
- 2005 Economic Society, 2005 World Congress, UCL, August 18-25.
- 2005 Kiawah Neuroeconomics meeting (workshop on fMRI analysis) Charleston, NC, Sept 15-18.
- 2005 Department of Economics, Princeton University, Oct. 4, 2005
- 2005 Novartis Foundation Symposium on Empathy and Fairness, London, UK, October 25-27.
- 2005 Distinguished Neuroscientist Lecture Series, U. Cincinnati, Nov. 8, 2005
- 2005 NIDA sponsored symposium at ACNP; Computational Models of Dopamine Function, Honolulu, HI, Dec 11-15

PUBLICATIONS (for downloadable versions see <http://www.hnl.bcm.edu/faculty.html>)

Montague, PR, Friedlander MJ (1989) Expression of an intrinsic growth strategy by mammalian retinal neurons. ***Proceedings of the National Academy of Science (USA)*** 86:7223-7227.

Gally, JA, Montague, PR, Reeke, GN, Edelman, GM (1990) The NO hypothesis: possible effects of a short-lived rapidly diffusible signal in the development and function of the nervous system. ***Proceedings of the National Academy of Science (USA)*** 87:3547-3551.

Montague, PR, Friedlander MJ (1991) Morphogenesis and territorial coverage by isolated mammalian retinal ganglion cells. ***Journal of Neuroscience*** 11(5):1440-1457.

Montague, PR, Gally, JA, Edelman, GM (1991) Spatial signaling in the development and function of neural connections. ***Cerebral Cortex*** 1(3):199-220.

Montague, PR (1993) The NO hypothesis. ***Encyclopedia of Neuroscience***, supp 3, eds. B. Smith and G. Adelman, pp. 100-103, Birkhauser : Cambridge, Mass.

Montague, PR, Dayan, P, Nowlan, SJ, Pouget, A, and Sejnowski, TJ (1993). Using aperiodic reinforcement for directed self-organization. ***Advances in Neural Information Processing Systems*** 5: 969-976. San Mateo CA: Morgan Kaufmann Publishers.

Montague, PR (1993) Translating sensory experience into structural change. ***Proceedings of the National Academy of Sciences (USA)*** 90(14):6379-6380.

Montague, PR, Dayan, P, Sejnowski, TJ (1993) Volume learning: Signaling covariance through neural tissue, In: J. Bower and F. Eeckman (Eds.) ***Computation and Neural Systems***, Norwell, MA.: Kluwer Academic Publishers, 377-382.

Montague, PR, Sejnowski, TJ (1994) The predictive brain: temporal coincidence and temporal order in synaptic learning mechanisms. ***Learning and Memory*** 1(1):1-33.

Montague, PR, Dayan, P, and Sejnowski TJ (1994) Foraging in an Uncertain Environment Using Predictive Hebbian Learning. ***Advances in Neural Information Processing Systems*** 6:598-605. San Mateo CA: Morgan Kaufmann Publishers.

Montague, PR, Gancayco, CD, Winn, M, Marchase, RB, and Friedlander, MJ (1994) Role of NO production in NMDA receptor-mediated neurotransmitter release in cerebral cortex. ***Science*** 263:973-977.

Montague, PR (1995) Integrating information at single synaptic connections. ***Proceedings of the National Academy of Science (USA)*** 92:2424-2425.

Montague, PR, Dayan, P, Person, C, Sejnowski, TJ (1995) Bee foraging in uncertain environments using predictive Hebbian learning. ***Nature*** 377:725-728. (***News and Views*** 683-684).

Sejnowski, TJ, Dayan, P, Montague, PR (1995) Predictive hebbian learning. ***Proceedings of Eighth ACM Conference on Computational Learning Theory***, Santa Cruz, CA, USA. New York, NY, p. 15-18.

Montague, PR, Dayan, P, Sejnowski, TJ (1996) A Framework for Mesencephalic Dopamine Systems Based on Predictive Hebbian Learning. ***Journal of Neuroscience*** 16(5):1936-1947.

Montague, PR (1996) The Resource Consumption Principle: attention and memory in volumes of neural tissue. ***Proceedings of the National Academy of Science (USA)*** 93(8):3619-3623.

Montague, PR (1996) General properties of the resource consumption principle of neural function. ***Journal of Physiology (Paris)*** 90(3-4):239-242.

Person, C, Egelman, DM, King, RD, Montague, PR (1996) Three-dimensional synaptic distributions influence neural processing through the resource consumption principle. ***Journal of Physiology (Paris)*** 90(5-6):330-333.

Goodhill, GJ, Bates, KR, Montague, PR (1997) Influences on the global structure of cortical maps. ***Proceedings of the Royal Society London B*** 264:1-7.

Schultz, W, Dayan, P, Montague, PR (1997) A neural substrate of prediction and reward. ***Science*** 275:1593-1599.

Montague, PR (1997) The cerebral code is still encrypted. A review of the The Cerebral Code. ***J. Chemical Neuroanatomy*** 14(1):67-68.

Montague, PR (1997) Biological substrates of predictive mechanisms in learning and action choice. ***Neural-Network Approaches to Cognition - Biobehavioral Foundations***. pp 406-421, J. Donahoe, ed, Elsevier Science Publishers.

Montague, PR, Dayan, P (1998) Neurobiological modeling: squeezing top down to meet bottom up. in: Bechtel, W. and Graham, G. (Eds.) ***A Companion to Cognitive Science***. Oxford: Blackwell, pp 526-542.

Egelman, DM, King, RD, & Montague, PR (1998) Interaction of nitric oxide and external calcium fluctuations: a possible mechanism for rapid information retrieval. ***Progress in Brain Research*** 118:199-211.

Egelman, DM, Montague, PR (1998) Computational properties of peri-dendritic calcium fluctuations. ***J. Neuroscience*** 18(21):8580-8589.

Egelman, DM, Person, C, Montague, PR (1998) A computational role for dopamine delivery in human decision-making. ***J. Cognitive Neuroscience*** 10(5):623-630.

Montague, PR, Quartz, SR (1999) Computational approaches to neural reward and development. ***Mental Retardation & Developmental Disabilities Research Reviews*** 5:86-99.

Montague, P.R. (1999) Review of Reinforcement Learning: An Introduction. ***Trends in Cognitive Science*** 3(9):360-61.

Egelman, D.M., Montague, P.R. (1999) Calcium dynamics in the extracellular space of mammalian neural tissue. ***Biophysical Journal*** 76(4):1856-1867.

Wiest, MC, Egelman, DM, King, RD, Montague, PR (2000) Dendritic spikes and their influence on extracellular calcium signaling. ***J Neurophysiology*** 83(3):1329-1337.

King, RD, Wiest, M, Egelman, D, Montague, PR (2000) Do extracellular calcium signals carry information through neural tissue? ***Trends in Neuroscience*** 23(1):12-13

Dayan, P, Kakade, S, Montague, PR (2000) Learning and Selective Attention. ***Nature Neuroscience*** 3 (supp) 1218-1223.

Perrett, SP, Dudek, SM, Eagleman, DM, Montague, PR, Friedlander, MJ (2001) LTD induction in adult visual cortex: role of stimulus timing and inhibition. ***J. Neuroscience*** 21(7):2308-2319.

King, RD, Wiest, MC, Montague, PR (2001) Extracellular calcium depletion as a mechanism for short-term synaptic depression. ***J. Neurophysiology*** 85(5):1952-1959.

Berns, GS, McClure, SM, Montague, PR (2001) Predictability modulates human brain response to reward ***J. Neuroscience*** 21(8):2793-2798.

Pagnoni, G, Zink, CF, Montague, PR, Berns, GS (2002) Activity in human ventral striatum locked to errors in reward prediction. ***Nature Neuroscience*** 5(2):97-98.

Montague, PR, Berns, GS, Cohen, JD, McClure, SM, Pagnoni, G, Dhamala, M, Wiest, MC, Karpov, I, King, RD, Apple, N, Fisher, RE (2002) Hyperscanning: simultaneous fMRI during linked social interactions. ***NeuroImage*** 16(4):1159-1164.

Montague, PR, Eagleman, DM, McClure, SM, Berns, GS (2002) Reinforcement Learning, ***Encyclopedia of Cognitive Science***. London, Eng: Macmillan Publishers Ltd. pp. 908-913.

Eagleman, DM, Montague, PR (2002) Models of learning and memory. ***Encyclopedia of Cognitive Science***, New York: MacMillan Publishers Ltd. pp. 806-812.

Montague, PR (2002) Uniting the Confederation. ***Trends in Neuroscience*** 25(11):595-596.

Montague, PR, Berns, GS (2002) Neural Economics and the biological substrates of valuation. ***Neuron*** 36:265-284.

McClure, SM, Berns, GS, Montague, PR (2003) Temporal prediction errors in a passive learning task activate human striatum. ***Neuron***. 38(2):339-346.

Montague, PR (2003) Uncertainty Rules. ***Nature*** 424:371-372.

McClure, SM, Daw, N, Montague, PR (2003) A computational substrate for incentive salience. ***Trends in Neuroscience*** 26(8):423-428.

McClure, SM, York, MK, Montague, PR (2004) The neural substrates of reward processing in humans: the modern role of functional magnetic resonance imaging. ***The Neuroscientist*** 10(3):260-268.

Montague, PR, McClure, SM, Baldwin, PR, Phillips, PEM, Budygin, EA, Kilpatrick, M, Stuber, G, Wightman RM (2004) Dynamic gain control of dopamine delivery in freely-moving animals. ***Journal of Neuroscience***, 24(7):1754 –1759

McClure, SM, Li, J, Tomlin, D, Cypert, KS, Montague, LM, Montague, PR (2004) Neural correlates of behavioral preference for culturally familiar drinks. ***Neuron*** 44:379-387.

Montague, PR, Hyman, SE, Cohen, JD (2004) Computational roles for dopamine in behavioural control. ***Nature*** 431: 760-767.

King-Casas, B., Tomlin, D., Anen, C., Camerer, C.F., Quartz, SR, Montague, PR (2005) Getting to know you: Reputation and Trust in a two-person economic exchange. ***Science*** 308:78-83 (***commentary*** p. 36)

Montague, PR, King-Casas, B, Cohen, JD (2006) Imaging valuation models in human choice. **Annual Review of Neuroscience** 29:417-448.

Tomlin, D, Kayali, MA, King-Casas, B, Anen, C, Camerer, CF, Quartz, SR, Montague, PR (2006) Agent-specific responses in cingulate cortex during economic exchanges. **Science** 312:1047-1050.

Potts GF, Martin LE, Burton P, Montague PR (2006) When things are better or worse than expected: the medial frontal cortex and the allocation of processing resources. **J. Cognitive Neuroscience** Jul:18(7):1112-1119.

Stetson, C, Cui, X, Eagleman, DM, Montague, PR (2006) Motor-sensory recalibration leads to an illusory reversal of action and sensation. **Neuron** 51:651-659

Li, J, McClure, SM, King-Casas, B, Montague, PR (2006) Policy Adjustment In A Dynamic Economic Game. **PlosONE** 1(1):e103

Cui X, Yang D, Jeter C, Montague PR, Eagleman DM (2007). Vividness of mental imagery: individual variation can be measured objectively. **Vision Research** 41(4):474-478.

Dani JA, Montague PR (2007) Disrupting addiction through the loss of drug-associated internal states. **Nature Neuroscience** 10(4): 403-04.

Montague, PR, Chiu, P (2007) For goodness' sake. **Nature Neuroscience** 10(2):137-138.

Lohrenz T, McCabe K, Camerer CF, Montague PR (2007) Neural signature of fictive learning signals in a sequential investment task. **Proceedings of the National Academy of Science (USA)** 104(22): 9493-98.

Bogacz R, McClure SM, Li J, Cohen JD, Montague PR (2007) Short-term memory traces for action bias in human reinforcement learning. **Brain Research** 1153:111-21.

Montague, PR (2007) The first wave. **Trends in Cognitive Sciences** 11(10): 407-409.

Montague, PR, Lohrenz, T (2007) To detect and correct: norm violations and their enforcement. **Neuron** 56(1):14-8.

Montague, PR (2007) Neuroeconomics: A View from Neuroscience. **Functional Neurology** 22(4): 219-234.

Montague, PR, King-Casas, B (2007) Efficient statistics, common currencies and the problem of reward-harvesting. **Trends in Cognitive Science** 11(12):514-519.

Chiu, PH, Kayali, MA, Kishida, KT, Tomlin, D, Klinger, LG, Klinger, MR, Montague, PR (2008) Self responses along cingulate cortex reveal quantitative neural phenotype for high-functioning autism. **Neuron** 57: 463-473.

Chiu, PH, Lohrenz, TM, Montague, PR (2008) Smokers' brains compute, but ignore, a fictive error signal in a sequential investment task. **Nature Neuroscience** 11(4):514-520.

Books:

Why Choose This Book? by Read Montague, (Dutton Press, Penguin Group) published November 2, 2006.

SOFTWARE DEVELOPMENT BY THE MONTAGUE GROUP

1982 (undergraduate) Developed computational methods for rapid *ab initio* calculations to estimate molecular orbital cross sections in ethane. Programs written in FORTRAN 77 and run on IBM 370.

1984-85 (medical student) Developed optimization programs for fitting multidimensional models to datasets derived from recordings of neuronal units from mammalian visual cortex. Program ran online under RT-11, DEC's real time operating system. Developed optimization programs for re-alignment and three dimensional reconstruction of stacked electron micrographic sections.

1986-1988 (graduate student) Developed computer programs to perform automatic calculation of Hausdorff dimension (one kind of fractal dimension) of neuronal structures – programs written in C, C++, and assembly code. Outcome of this work was communicated to Proceedings of National Academy of Science by Torsten Wiesel.

1989 (postdoctoral fellow) Developed neural network simulation and simulation environment. Received patent 5,485,546 for the methods by which the simulations learn from experience. In the neuroscience community, the learning rule is now known as 'volume learning'. Also developed algorithms for mapping spatial problems onto massively parallel supercomputers. In particular, a fast method for mapping problems onto hypercube topologies (e.g. N-Cube computer) was developed. Program also allowed the growth and development of volumes of neural tissue. This work was carried out in collaboration with Gerald M. Edelman (Rockefeller University, New York, NY)

1991 Developed reinforcement learning algorithm to explain foraging behavior in bees. Developed learning algorithms to explain self-organized development of the visual cortex. Implemented in C on Sun, Silicon Graphics workstations. Also ported to parallel Intel Paragon computer (512 processors).

1993 Developed virtual environment simulation in which a simulated bee moved about and foraged on a simulated field of flowers. The entire world was dynamic with the bee gathering sensory information while moving and learning to improve its foraging behavior. The simulated field also grew and changed. This work was profiled in Nature magazine, Time magazine, New York Times, London Daily Telegraph, and other major journalistic outlets. Code written in C and implemented on Silicon Graphics workstations.

1996 Developed new simulation environment for estimating calcium dynamics in the extracellular space of mammalian neural tissue. This simulation used a combination of Monte Carlo and finite difference techniques and was written in C. It is now being ported to a Java implementation for use over the web.

1998 Developed model of human economic decision-making using Java program that samples human's decision-making performance and predicts future performance. Also, developed Java simulation of fluctuations of dopamine delivery to brain tissue. Dopamine systems are those hijacked by drugs of abuse. This work was profiled on a PBS special, New York Times Science Section, Japanese News Magazine (Fuji Television Network), and other news outlets.

2000 Designed and implemented a method for linking ongoing fMRI scanning experiments over the web (**hyperscanning**). This software is written in Java. Pilot 'linked scanner' experiments have now been carried out at Emory University and Princeton University.

2002-2003 Led development of full web-based Hyperscan software that allows for simultaneous brain scanning of behaviorally interacting subjects. This software has made possible the simultaneous study of socially interacting brains. This project is organized through the Human Neuroimaging Laboratory at Baylor College of Medicine. It is an open source project with release scheduled for fall 2003. The software modules for remotely executing, monitoring, and analyzing functional MRI experiments will be included in the release.

2005 March 15, 2005. Open source release of hyperscan software (called NEMO) for remote synchronization, control, and viewing of fMRI experiments (see <http://www.hnl.bcm.edu/nemo/>). May 31, 2005 – First inter-continental hyperscan experiment using two-person trust exchange, Baylor College of Medicine and Hong Kong University of Science and Technology. July 5, 2005 – Second intercontinental hyperscan experiment, Baylor College of Medicine and Universitat Ulm

2006 Graphical user interface development and generalization of NEMO into a multi-user, multi-site tool for interactive social exchange experiments.